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(54) Electric heater unit and method of manufacture

(57) An electric heater unit is manufactured so as to form a base (8) in a supporting dish (4) by compacting powdered microporous insulation into the base. At least one electrical resistance heating element (12) is supported on or adjacent to the base and a peripheral wall (11) is formed in the supporting dish and integral with the base by compacting further microporous insulation material into the dish to a controlled compaction density. The compaction density of the peripheral wall (11) may be different from that of the base, for example higher.

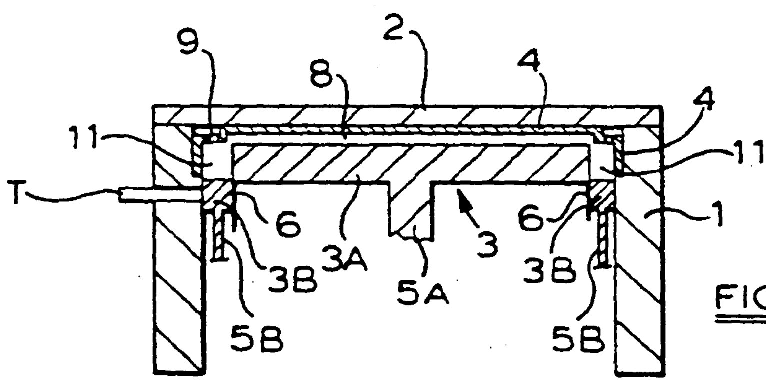

FIG 4

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D scription

This invention relates to an electric heater unit, particularly but not exclusively for use in glass-ceramic cooking appliances, and a method for manufacture thereof.

Heaters for use in glass-ceramic surface electric cooking equipment are well known, having an insulation material in the shape of a bowl comprising a base and peripheral wall, the base supporting, or having adjacent thereto, one or more heating conductors in the form of an electrical resistance material formed as a wire coil, a ribbon, a halogen infra red tube or other means.

The electrical and thermal insulation material is a critical component. At least a part of the base insulation may be a high performance insulation which is a compacted microporous material.

The term 'microporous' is used herein to identify porous or cellular materials in which the ultimate size of the cells or voids is less than the mean free path of an air molecule at NTP, i.e. of the order of 100 nm or smaller. A material which is microporous in this sense will exhibit very low transfer of heat by air conduction (that is, due to collisions between air molecules). Such microporous materials include aerogel, which is a gel in which the liquid phase has been replaced by a gaseous phase in such a way as to avoid the shrinkage which would occur if the gel were dried directly from a liquid. A substantially identical structure can be obtained by controlled precipitation from solution, the temperature and pH being controlled during precipitation to obtain an open lattice precipitate. Other equivalent open lattice structures include pyrogenic (fumed) and electro-thermal types in which a substantial proportion of the particles have an ultimate size less than 100 nm. Any of these materials, based, for example on silica, alumina, other metal oxides, or carbon, may be used to prepare a composition which is microporous as defined above.

Optionally a binder may be added to provide increased strength, in which case a heat treatment may be necessary in order to cure the binder.

A known form of high performance microporous thermal insulation material comprises microporous silica particles compacted to consolidate the material into a handleable form, and typically includes ceramic fibre or glass filam nt reinforcement and rutile powder opacifier.

The microporous insulation may be directly in contact with the heating conductor, acting as a support for the conductor.

Alternatively the conductor may be supported by a lesser thermal insulation material which has mechanical properties quite different from the microporous thermal insulation. In this case the base support and peripheral wall may be formed as one piece with the wall and base being a homogeneous material.

When the base is a microporous insulation it has been found to be advantageous to have the peripheral wall made from a separate stronger material. Heaters have been made which have wall and base support formed as pressed microporous insulation material but the walls were mechanically weak and a stronger material was fitted to the top of the peripheral wall to improve handle ability.

Another design idea uses a microporous base support with a separate wall component also made from microporous insulation. It is claimed that the separate wall component can be made with high mechanical strength and good insulation properties. The higher strength is achieved by a special hardening process. This solution is costly. The wall component is slow to produce and needs care in handling.

It is an object of the present invention to provide a high strength microporous wall component at low cost.

According to one aspect of the present invention there is provided an electric heater unit comprising a supporting dish having therein a base of compacted microporous insulation material, at least one electrical resistance heating element supported on, or adjacent to, the base, and a peripheral wall of compacted microporous insulation material, wherein the peripheral wall is integral with the base and is of controlled compaction density.

According to a further aspect of the invention there is provided a method of manufacturing an electric heater unit comprising the steps of providing a supporting dish, forming in the supporting dish a base by compacting powdered microporous insulation material therein, and providing at least one electrical resistance heating element supported on or adjacent to the base, wherein the method includes the additional step of forming in the supporting dish a peripheral wall integral with the base by compacting further microporous insulation material into the dish to a controlled compaction density.

The compaction density of the peripheral wall may be different from that of the base. For example, the peripheral wall may be of higher compaction density than the base.

In one embodiment of the method according to the invention a press tool is provided having separable central and surrounding peripheral portions, powdered microporous insulation material is compacted into the supporting dish with the press tool to form the base and, optionally, part of the peripheral wall, the peripheral portion of the press tool is retract d to form a cavity into which further powdered microporous insulation material is introduced, the peripheral portion of the press tool is advanced to compact th further powdered microporous insulation material to a controlled compaction density to form the peripheral wall integral with the base, and the central and peripheral portions of the press tool are retracted from the dish

In a further embodiment of the method according to the invention, powdered microporous insulation material is compacted into the supporting dish with a press tool to form the base and, optionally, part of the peripheral wall, the press tool and the dish are then separated and a further press tool having separable central and surrounding peripheral portions is provided, at least one electrical resistance heating element is supported at a face of the central portion of the press tool and is pressed by the press tool into the surface of the base of compacted microporous insulation material in the supporting dish for partial embedding therein, the peripheral portion of the further press tool is retracted to form a cavity into which further powdered microporous insulation material is introduced, the peripheral portion of the further press tool is advanced to compact the further powdered microporous insulation material to a controlled compaction density to form the peripheral wall integral with the base, and the central and peripheral portions of the further press tool are retracted from the dish, leaving the heating element securely partially embedded in the base.

The powdered microporous insulation material and/or the further powdered microporous insulation material may be introduced into the press tool by way of a tube through a wall thereof. The powdered material may be pumped through the tube such as by using high pressure gas induction or by using a vane pump, a diaphragm pump or a peristaltic pump.

The supporting dish may be circular and the press tool with separable central and surrounding peripheral portions may have a circular central portion and an annular surrounding peripheral portion.

The further powdered microporous insulation material may have a composition substantially the same as, or different from, that of the material forming the base.

The peripheral wall of compacted microporous insulation material preferably is under internal compressive strain after provision in the supporting dish.

The peripheral wall is suitably arranged to have a top surface capable of contacting the underside of a glass-ceramic cook top of a cooking appliance, in particular the peripheral wall may have a height at least as great as the height of side walls of the supporting dish. Such top surface may be profiled such that it is higher at its centre than at its edges.

The peripheral wall and/or the base may include reinforcing glass filaments. Such filaments may, for example, be selected from E glass, R glass, S glass and silica.

The supporting dish may comprise a metal.

The at least one electrical resistance heating element may, for example, comprise coiled wire or coiled ribbon, or plane or corrugated ribbon disposed flat or edgewise, on or adjacent to the base in the supporting dish.

By means of the invention a peripheral wall of microporous insulation material is provided in which the composition and the compaction density thereof are the same as or different from a base of microporous insulation material with which it is integrally provided.

The invention is now described by way of example with reference to the accompanying drawings, in which:

Figures 1 to 7 are cross-sectional views of an arrangement illustrating process steps in the manufacture of an electric heater unit according to the invention;

Figures 8 to 15 are cross-sectional views of a further arrangement illustrating process steps in the manufacture of an electric heater unit according to the invention; and

Figure 16 is a plan view of an embodiment of electric heater unit manufactured according to the invention.

Referring to Figure 1, a press for use in manufacturing an electric heater unit according to the invention comprises a housing 1, a cover 2 and a press tool 3 which is slidable inside the housing 1. The end of the housing 1 is recessed to receive the rim of a metal dish 4 which will form the supporting dish for the electric heater unit.

The press tool 3 is of circular shape and comprises a circular central portion 3A and an annular surrounding peripheral portion 3B. The central portion 3A and annular portion 3B are separable from one another and are slidable in the housing by means of plungers 5A and 5B.

The central portion 3A has an extended cylindrical wall 6 able to slidably interface with the annular portion 3B.

Operation of the press commences with retraction of the press tool 3 to the position shown in Figure 1.

A predetermined quantity of powdered microporous thermal insulation material is introduced into the space 7 between the press tool 3 and the dish 4. By way of example only, the insulation material may have the following composition:

Pyrogenic silica	60 percent by weight
Opacifier (Rutile)	37 percent by weight
Ceramic fibres	3 percent by weight

The powdered material may be introduced into the space 7 before the dish 4 and cover 2 are installed. Alternatively it may be pumped into the space 7 by way of a tube T passing through the wall of the housing 1. Pumping of the powder through the tube T may be by using high pressure gas induction or using a vane pump, a diaphragm pump, or a peristaltic pump.

The press is operated, for example hydraulically, to urge both portions 3A and 3B of the press tool simultaneously towards the dish 4, by means of the plungers 5A and 5B, as shown in Figure 2, thereby compacting the insulation material into the dish 4 to form a base 8 in the dish.

During the compacting operation, air is displaced from the press through holes 9 at the periphery of the dish 4 and also via the interface between the press tool 3 and the housing 1. If required, holes (not shown) may be provided through the press tool 3 to further facilitate air displacement.

The compacted insulation material forming the base 8 may be formed with a step 8A at the edge thereof, by forming a complementary step in the press tool 3. Such step 8A forms a base portion of a peripheral wall of insulation material which is to be provided in the dish as hereinafter described.

As shown in Figure 3, the next step in the process is to retract the annular portion 3B of the press tool, by means of the plungers 5B while leaving the central portion 3A of the press tool in contact with the surface of the base 8 of insulation material. Further powdered microporous insulation material is then pumped through the tube T into the space 10 vacated by the annular portion 3B of the press tool.

As shown in Figure 4, the annular portion 3B of the press tool is then advanced towards the dish 4 to compact the further insulation material to form a peripheral wall 11 of microporous insulation material integrally moulded with the base 8 of microporous insulation material. The wall 11 is arranged to be compacted to a higher compaction density than that on average of the base 8. For example the base 8 may have a compaction density of about 300 kg/m^3 whereas the wall 11 may be compacted to a density of about 350 kg/m^3.

The wall 11 may have a composition the same as, or different from, that of the base 8. An example of a particular composition for the wall is:

Pyrogenic silica	62 percent by weight
Opacifier (Rutile)	27 percent by weight
E glass filaments	11 percent by weight

Both portions 3A, 3B of the press tool are then retracted as shown in Figure 5, the cover 2 is removed and the dish 4 with the base 8 and peripheral wall 11 therein is extracted. The dish 4 with the base 8 and peripheral wall 11 therein is shown in Figure 6. The peripheral wall 11 has a height corresponding at least to the height of side walls of the dish 4, and preferably extending somewhat above the side walls of the dish 4.

To complete the heater unit, an electrical resistance heating element 12 is provided supported on the base 8 of microporous thermal insulation material as shown in Figure 7. Heating element 12 may comprise any of the well known forms, such as coiled wire or ribbon or a corrugated ribbon supported edgewise and partly embedded in the base 8. Such a corrugated ribbon form of element is shown in Figure 7 and also in Figure 16, which represents a plan view of the heater of Figure 7 and in which there is additionally provided a well known form of temperature limiter 13.

The heater of Figures 7 and 16 is intended for operation in a glass-ceramic top cooking appliance (not shown) where it is secured beneath a glass-ceramic cook top (not shown) with the upper surface 11A of the peripheral wall in contact with the underside of the glass-ceramic top.

As shown by the dotted outline 14 in Figures 6 and 7, the top surface of the peripheral wall 11 may be profiled such that it is higher at its centre than at its edges. This is achieved by providing a complementary profile on the inner face 14A of the annular portion 3B of the press tool (Figure 5).

Figures 8 to 15 illustrate an alternative process sequence including the moulding of corrugated ribbon heating element 12 into base 8 of microporous insulation material.

Referring to Figure 8, a press is provided, as in Figure 1, comprising a housing 1 recessed to receive the rim of a metal dish 4 forming the supporting dish of an electric heater unit. A cover 2 is provided for the housing. A circular press tool 3 is provided, slidable in the housing 1 by means of a plunger 5.

With the press tool in the position shown in Figure 8, a predetermined quantity of powdered microporous thermal insulation material is introduced into the space 7 between the press tool 3 and the dish 4 using either of the methods as previously described with reference to Figure 1. The press is operated to urge the press tool 3 towards the dish 4, as shown in Figure 9, thereby compacting the insulation material into the dish 4 to form a base 8 in the dish. The press tool 3 is then withdrawn from the housing and replaced by the press tool shown in Figure 10, which is of two part form as previously d scribed with reference to Figure 1, having a central circular portion 3A operated by a plunger 5A and an annular peripheral portion 3B operated by plungers 5B The top surface 15 of the central portion 3A of the press

tool is provided with a pattern of grooves to partially receive therein a corrugated ribbon heating element 12. The press tool 3A, 3B is advanced by means of plungers 5A, 5B towards the base 8 of compacted insulation material, as shown in Figure 11, to cause the heating element 12 to be partially embedded in the surface of the base 8. It may be advantageous if, during the initial provision of the base 8, as described with reference to Figures 8 and 9, the microporous insulation material of the base 8 is compacted to less than its required final density. This facilitates embedding of the heating element 12 therein and subsequent to such embedding, the base 8 is compacted to its desired final density by pressure exerted thereon by the surface of the press tool 3A, 3B.

With the central portion 3A of the press tool retained in the position shown in Figure 11, the annular peripheral portion 3B of the press tool is retracted by the plungers 5B into the position shown in Figure 12. Further powdered microporous insulation material is then pumped through tube T into the space 10 vacated by the annular portion 3B of the press tool.

As shown in Figure 13, the annular portion 3B of the press tool is then advanced towards the dish 4 to compact the further insulation material to form a peripheral wall 11 of microporous insulation material integrally moulded with the base 8 of microporous insulation material. The wall 11 is arranged to be compacted to a higher compaction density than that on average of the base 8.

The wall 11 may have a composition the same as, or different from, that of the base 8.

Both portions 3A, 3B of the press tool are then retracted as shown in Figure 14, leaving the heating element 12 securely partially embedded in the base 8. It is preferred that the central portion 3A of the press tool is retracted before the annular portion 3B to minimise risk of damage to material of the wall 11. The cover 2 is removed from the press and the heater unit comprising the dish 4, with the base 8, peripheral wall 11 and heating element 12, extracted. Such heater unit is shown in section in Figure 15 and, after the addition of a temperature limiter 13, in plan view in Figure 16.

Claims

1. An electric heater unit comprising a supporting dish (4) having therein a base (8) of compacted microporous insulation material, at least one electrical resistance heating element (12) supported on or adjacent to the base, and a peripheral wall (11) of compacted microporous insulation material, characterised in that the peripheral wall is integral with the base and is of controlled compaction density

2. A heater unit as claimed in claim 1, characterised in that the compaction density of the peripheral wall (11) is different from that of the base (8).

3. A heater unit as claimed in claim 2, characterised in that the peripheral wall (11) is of higher compaction density than the base (8).

4. A heater unit as claimed in claim 1, 2 or 3, characterised in that the compacted microporous insulation material forming the peripheral wall (11) has a composition substantially the same as, or different from, that of the compacted microporous insulation material forming the base (8).

5. A heater unit as claimed in any preceding claim, characterised in that the peripheral wall (11) is under internal compressive strain.

6. A heater unit as claimed in any preceding claim, characterised in that the peripheral wall (11) has a top surface (11A) capable of contacting the underside of a glass-ceramic cook top of a cooking appliance, in particular the peripheral wall having a height at least as great as the height of side walls of the supporting dish (4).

7. A heater unit as claimed in claim 6, characterised in that the top surface (11A) of the peripheral wall (11) is profiled (14) such that it is higher at its centre than at its edges.

8. A heater unit as claimed in any preceding claim, characterised in that the peripheral wall (11) and/or the base (8) includes reinforcing glass filaments, for example selected from E glass, R glass, S glass and silica.

9. A heater unit as claimed in any preceding claim, characterised in that the supporting dish (4) comprises a metal.

10. A heater unit as claimed in any preceding claim, characterised in that the at l ast one electrical resistance h ating element (12) comprises coiled wire or coiled ribbon, or comprises plane or corrugated ribbon disposed flat or edgewise, on or adjacent to the base (8) in the supporting dish (4)

11. A method of manufacturing an electric heater unit comprising the steps of providing a supporting dish (4), forming in the supporting dish a base (8) by compacting powdered microporous insulation material therein, and providing at least one electrical resistance heating element (12) supported on or adjacent to the base characterised by the additional step of forming in the supporting dish a peripheral wall (11) integral with the base by compacting further microporous insulation material into the dish to a controlled compaction density.

12. A method according to claim 11, characterised in that the compaction density of the peripheral wall (11) is different from that of the base (8).

13. A method according to claim 12, characterised in that the further powdered microporous insulation material is compacted to a compaction density higher than that of the base (8).

14. A method according to claim 11, 12 or 13, characterised in that a press tool (3) is provided having separable central (3A) and surrounding peripheral (3B) portions, powdered microporous insulation material is compacted into the supporting dish (4) with the press tool to form the base (8) and, optionally, part of the peripheral wall (11), the peripheral portion (3B) of the press tool is retracted to form a cavity (10) into which further powdered microporous insulation material is introduced, the peripheral portion of the press tool is advanced to compact the further powdered microporous insulation material to a controlled compaction density to form the peripheral wall integral with the base, and the central and peripheral portions of the press tool are retracted from the dish.

15. A method according to claim 11, 12 or 13, characterised in that powdered microporous insulation material is compacted into the supporting dish (4) with a press tool (3) to form the base (8) and optionally, part of the peripheral wall (11), the press tool and the dish are then separated and a further press tool having separable central (3A) and surrounding peripheral (3B) portions is provided, at least one electrical resistance heating element (12) is supported at a face (15) of the central portion of the press tool and is pressed by the press tool into the surface of the base of compacted microporous insulation material in the supporting dish for partial embedding therein, the peripheral portion (3B) of the further press tool is retracted to form a cavity (10) into which further powdered microporous insulation material is introduced, the peripheral portion of the further press tool is advanced to compact the further powdered microporous insulation material to a controlled compaction density to form the peripheral wall (11) integral with the base, and the central and peripheral portions of the further press tool are retracted from the dish, leaving the heating element securely partially embedded in the base.

16. A method according to claim 14 or 15, characterised in that the powdered microporous insulation material and/or the further powdered microporous insulation material is or are introduced into the press tool (3) by way of a tube (T) through a wall thereof.

17. A method according to claim 16, characterised in that the powdered material is pumped through the tube (T).

18. A method according to claim 17, characterised in that the material is pumped using high pressure gas induction or using a vane pump, a diaphragm pump or a peristaltic pump.

19. A method according to any of claims 14 to 18, characterised in that the supporting dish (4) is circular and the press tool (3) with separable central (3A) and surrounding peripheral (3B) portions has a circular central portion and an annular surrounding peripheral portion.

20. A method according to any of claims 11 to 19, characterised in that the further microporous insulation material has a composition substantially the same as, or different from, that of the material forming the base (8).

21. A method according to any of claims 11 to 20, characterised in that the peripheral wall (11) of compacted microporous insulation material is under internal compressive strain after provision in the supporting dish (4).

22. A method according to any of claims 11 to 21, characterised in that the peripheral wall (11) is arranged to have a top surface (11A) capable of contacting the underside of a glass ceramic cook top of a cooking appliance, in particular th periph ral wall having a height at least as great as the h ight of side walls of the supporting dish (4).

23. A method according to claim 22, characteris d in that th top surface (IIA) of th peripheral wall (11) is profiled (14) such that it is higher at its centre than at its edges.

24. A method according to any of claims 11 to 23, characterised in that the peripheral wall (11) and/or the base (8) includes reinforcing glass filaments, for example selected from E glass. R glass, S glass and silica.

25. A method according to any of claims 11 to 24, characterised in that th supporting dish (4) comprises a metal.

26. A method according to any of claims 11 to 25, characterised in that the at least one electrical resistance heating element (12) comprises coiled wire or coiled ribbon, or comprises plane or corrugated ribbon disposed flat or edgewise, on or adjacent to the base (8) in the supporting dish (4).

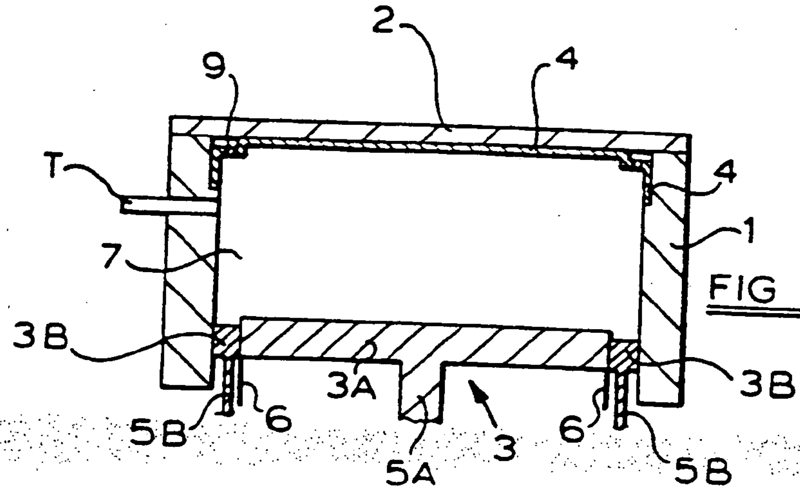

FIG 1

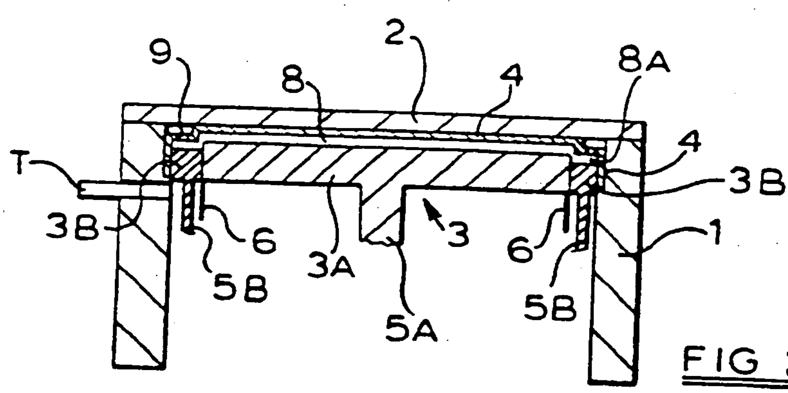

FIG 2

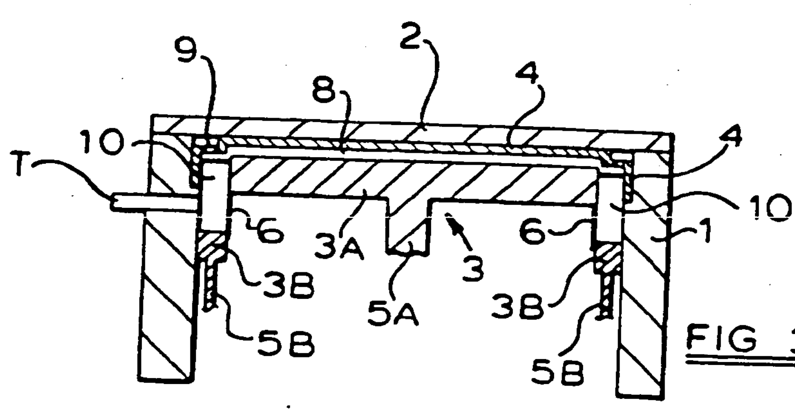

FIG 3

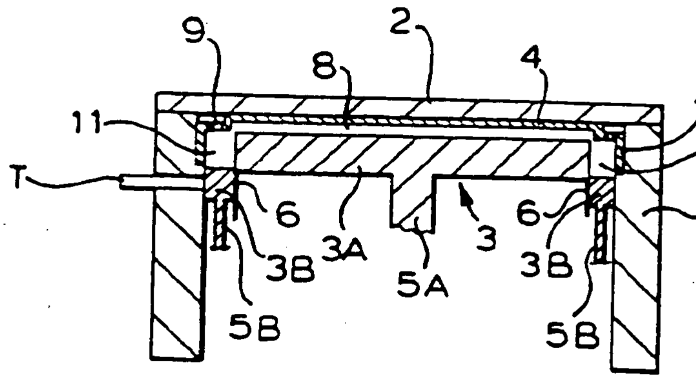

FIG 4

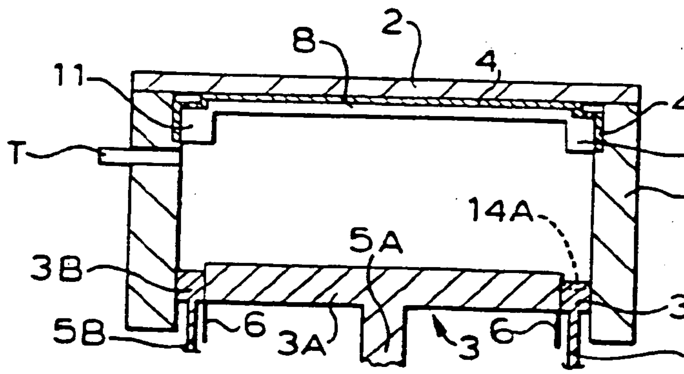

FIG 5

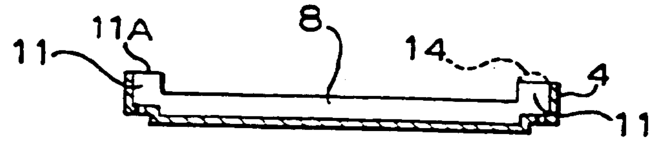

FIG 6

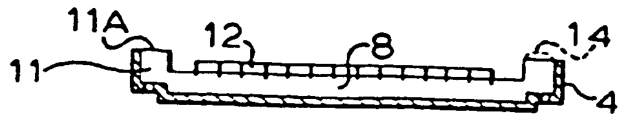

FIG 7

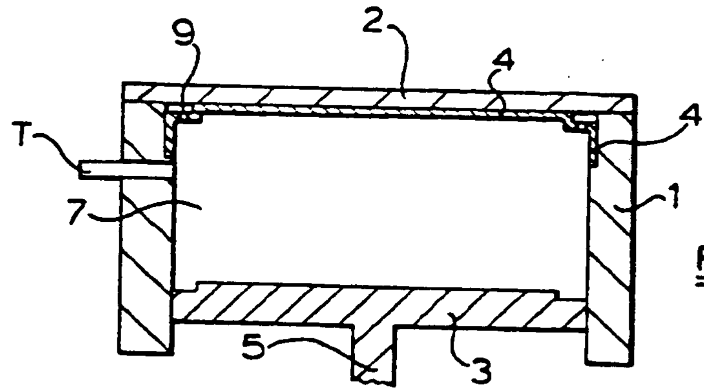

FIG 8

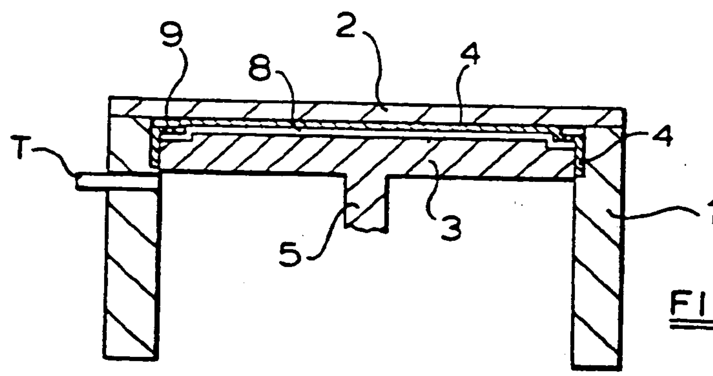

FIG 9

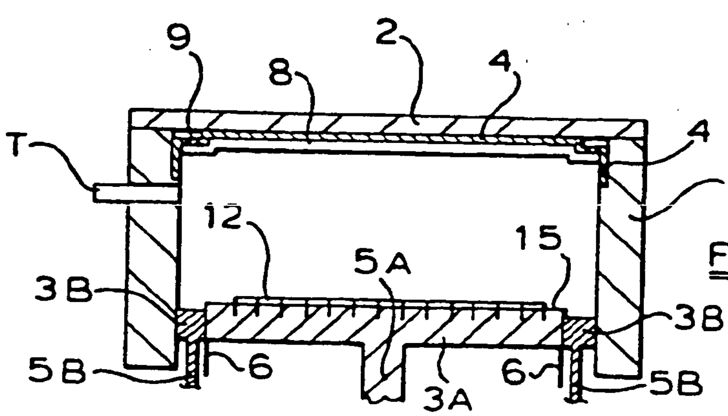

FIG 10

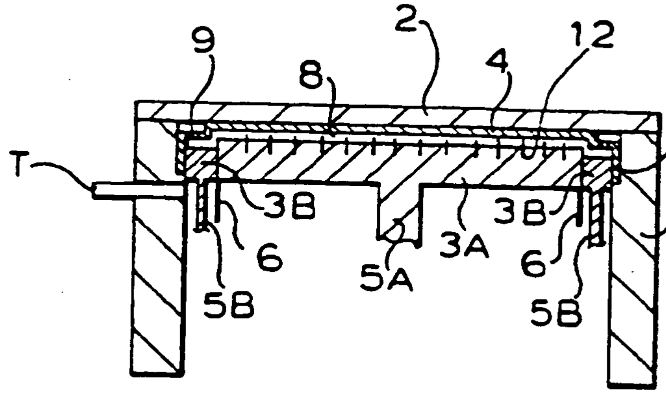

FIG 11

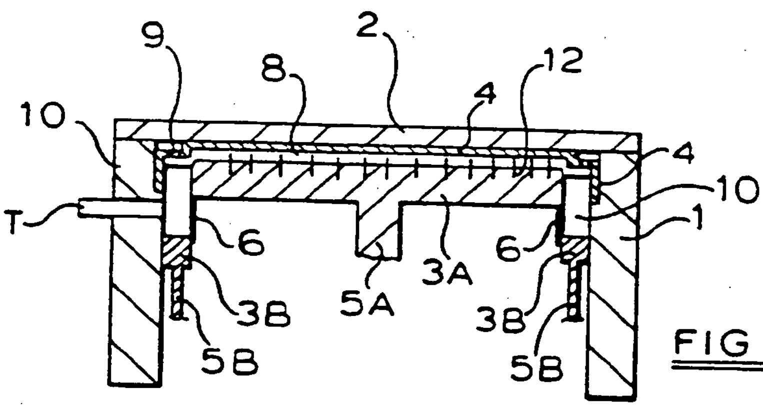

FIG 12

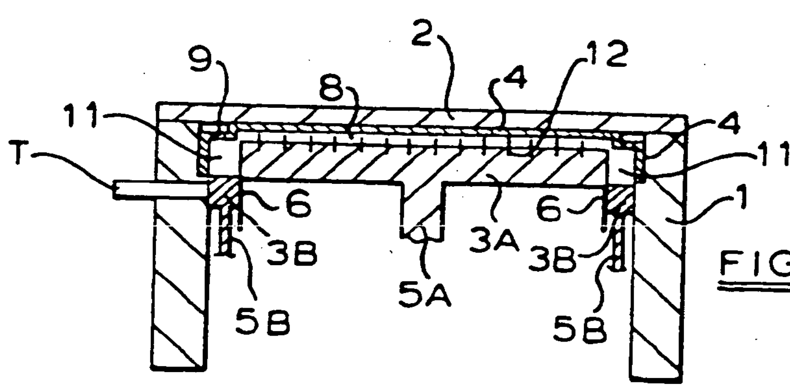

FIG 13

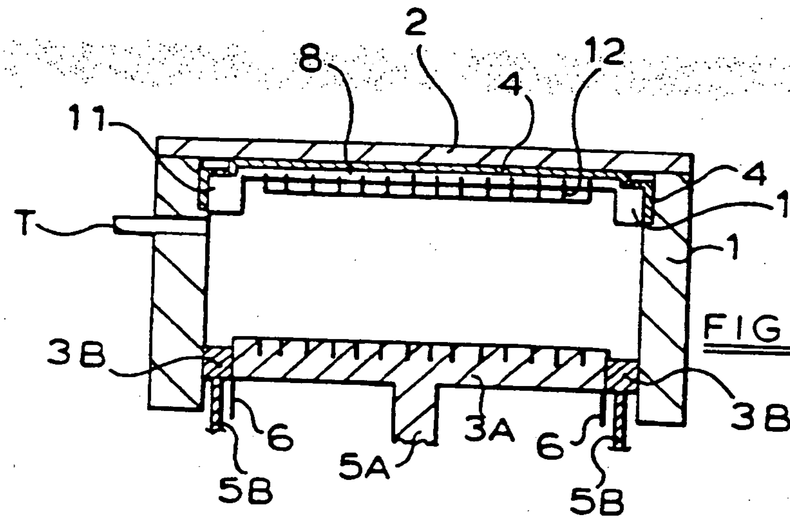

FIG 14

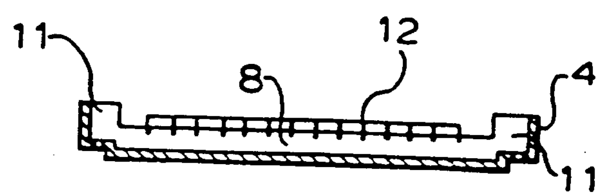

FIG 15

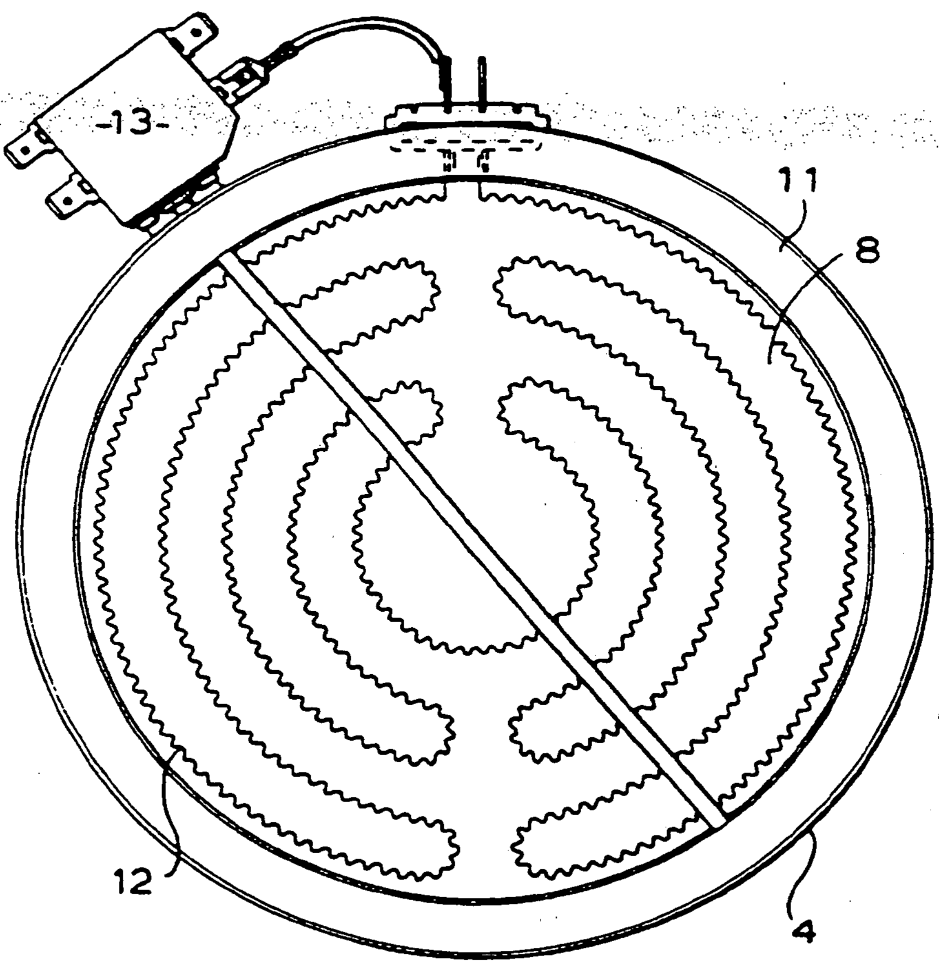

FIG. 16

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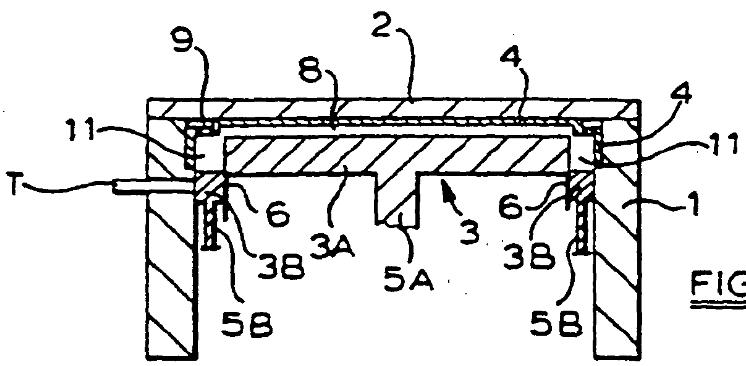

FIG 4

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 041 203 A (GRUENZWEIG HARTMANN GLASFASER) 9 December 1981 * page 5, line 18 - line 36; claims 7,12 *	1-3,6, 10-12	H05B3/74
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 December 1998	De Smet, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document